

Chapter 17

An example of public aquarium science: the CORALZOO project

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ABSTRACT

This short communication describes the CORALZOO project, a European Union funded, concerted effort of zoo's, public aquaria, ornamental trade and scientists to improve the methodology for breeding and husbandry of stony corals.

INTRODUCTION

Collaborative projects

In 2004, a group of scientists and public aquaria expressed their interest in collaboration on breeding and husbandry of scleractinian corals. A project proposal entitled CORALZOO was submitted to the Collective Research Program of the European Commission, which is part of the Sixth Framework Program for Science and Technology development (FP6) of the European Union. In Collective Research Projects, research institutions and universities collaborate with Small and Medium-sized Enterprises (SME's) on applied topics that are relevant to the core business of these SME's. The topics studied should represent issues of concern for an entire industrial branch. An Industrial Association or Grouping (IAG) representing a large community of SME's must be participating to the project. In the case of CORALZOO, the European Association for Zoos and Aquaria (EAZA) acts as the IAG partner. EAZA represents over 250 zoos and public aquaria.

In December 2004, the CORALZOO proposal was favorably evaluated and the project started in June 2005. With a total budget of 3.3 million euro and a duration of four years, it is the largest of all current Collective Projects. In addition, it is one of the world's largest concerted research efforts in the field of coral science. The CORALZOO consortium (Table 1; Figure 1) consists of three universities, a research institution, ten zoos and public aquaria, a coral culture company and EAZA.

OBJECTIVES AND STRUCTURE OF THE PROJECT

The full title of CORALZOO is: "The development of an SME-friendly European Breeding Program for hard corals". Its main objectives are:

1. To acquire the protocols for sexual and asexual coral **breeding** in captivity, including breeding and feeding techniques and induction of natural coral colony morphogenesis
2. To improve coral **husbandry** by:
 - a. developing generic bioassays to evaluate biotic and abiotic husbandry parameters and to monitor coral health,
 - b. elaborating methods for identification and treatment of coral diseases,
 - c. optimisation of transport and acclimation practices
3. To **train** the SME's staff with coral breeding and husbandry protocols and methodologies

The two anticipated main project results are:

- A book of protocols for coral breeding and coral husbandry
- The launch of a European Breeding Program on stony corals, executed under auspices of EAZA following the procedures outlined in the book of protocols. EAZA's current breeding programs (for birds and mammals) are designed to maintain genetically diverse populations of endangered species in captivity for the purpose of conservation. Although it may be

- desired to establish such a program for endangered coral species as well, the first focus for CORALZOO is to initiate a breeding program for the stocking of life coral exhibits, in order to meet the desire of zoos and public aquaria to refrain from obtaining wild-harvested animals.

In order to address these objectives, a work-plan was prepared, which is divided into eleven designated work packages (Table 2). The scientific work packages reflect the most important issues of concern identified by aquarists with respect to coral breeding and husbandry. A short description of the work preformed in each package is given in the next section.

WORK PACKAGE DESCRIPTIONS AND PROGRESS

Work package 1: Bioassay development.
A toolkit needed to execute studies within this project is being developed, which consists of (i) a generic bioassay for studies on fragmentation, feeding, growth, abiotic factors etc based on coral nubbins and (ii) an assay for health monitoring based on the expression of Heat Shock Protein 70 genes. Standardized procedures for preparing and handling of coral nubbins were recently published (Shafir et al., 2006). A series of more than thousand nubbins obtained from ten genetically different colonies of *Stylophora pistillata* was successfully shipped from Israel to seven CORALZOO partners in Europe. A shipment protocol was deduced from this exercise. These nubbins will be used for comparative growth studies and health monitoring.

Work package 2: Fragmentation.

The goal of this work is to optimize techniques for asexual propagation of a series of frequently bred coral species by executing comparative studies on different fragmentation techniques. An analysis of the existing coral culture systems within the CORALZOO team revealed that currently, a considerably heterogeneity exists within systems, in particular with respect to light availability and water movement. Systems were modified accordingly, and optimal sample sizes for comparative fragmentation studies have been determined for seven coral species. Optimization studies for these

species are currently in progress.

Work package 3: Sexual reproduction.

In order to maintain genetic variability among corals in captivity, natural reproductive behavior should occur. In CORALZOO, we attempt to develop strategies to induce spawning in tank systems. At present, the work has focused on identifying factors that regulate sexual reproduction of corals in a sea-based hatchery (Amar and Rinkevich, 2007) and for subsequent handling (transportation and husbandry) of the produced offspring.

Work package 4: Abiotic factors.

We aim to identify the optimal conditions for the target coral species with respect to availability of light, movement of water and chemical water composition. Most of the work concentrated on *Galaxea fascicularis* as a model species. Long term (one year or longer) growth monitoring studies were performed under different irradiance and current regimes. Preliminary data show that this species grows best under the highest irradiance level applied ($400 \mu\text{E} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$) and under the highest current velocity applied ($25 \text{ cm} \cdot \text{s}^{-1}$). Current studies focus on the relationship between feeding efficiency and current velocity and on the effect of different day-night rhythms on coral growth.

Work package 5: Nutrition.

This work deals with finding the best food type, quantity and timing of administration for corals. The effect of different concentrations of phytoplankton-based food, zooplankton-based food and dry fish food on the performance of the coral species *Stylophora pistillata* and *Pocillopora damicornis* was tested. The most promising results were obtained with dry fish food and the brine shrimp *Artemia salina*. In addition, the digestive system of a coral (*Stylophora pistillata*) is being characterized (using histology and histochemistry) in order to provide a further rationale for the choice of food types.

Work package 6: Health control.

This work mainly deals with identifying the most frequently occurring diseases among corals in captivity, describing the pathology of these diseases and development of diagnostics and cures. An intensive survey among aquarists and (grey) literature showed that the frequency distribution of diseases in aquaria differs from natural coral reefs. A cluster of disease-

like phenomena termed “white syndromes” occur most often in aquaria (~70% of the records), brown jelly syndromes being the second most frequently occurring disease pattern. Rapid Tissue Necrosis or Shut Down Reaction is the most progressive type among the white syndromes. It was recently found by CORALZOO scientists that this disease is caused by a well-known marine pathogen, *Vibrio harveyi* (Luna *et al.*, 2007). Subsequent work focuses on development of a treatment for this particular disease. Additional work within this work package is done on pest control (e.g. *Planaria* flatworms).

Work package 7: Transport and acclimation.
The goal of this work package is to improve the existing techniques for transport and acclimation and to increase the survival rates. Appropriate transportation protocols for coral larvae and coral nubbins have been established. Transportation methods for adult colonies also exist (a survey among CORALZOO partners learned that survival is usually almost 100%), but these techniques are rather expensive. The main aim is to reduce the transportation costs without reducing the survival rates. We are currently comparing and improving dry and wet transportation methods.

Work package 8: Morphogenetic modeling.
The objective is to describe growth patterns and translate these into a mathematical model that relates growth to environmental factors. This knowledge will be applied to breed corals that exhibit a natural growth form. Mathematical modeling studies are being executed that describe how a combination of genetic and environmental factors govern branching patterns in *Stylophora pistillata*. The models will be validated with experimental growth data.

Work package 9: Protocol composition and dissemination.

Most of the results will be translated into user-friendly protocols (which will be disseminated through the CORALZOO website, www1). The protocols will be used to initiate a European Breeding Program for corals with the main aim to produce coral stocks for aquarium exhibits. In this program, participating zoos and aquaria will use optimized protocols for growing stocks of one or few designated target species (i.e.: Zoo “X” is specialist-breeder of species “Y”). The different species can then

be exchanged within the zoo community. Further dissemination of CORALZOO results is achieved through scientific publications, articles in magazines and newspapers, radio and TV and presentations on conferences. The Coral Husbandry Conference was one of the most relevant dissemination events for CORALZOO: several CORALZOO-related papers were presented during the conference and have been published in this volume.

Work package 10: Training.

Training workshops will be organized to teach zoo staff (aquarists) how to use and implement the knowledge obtained within CORALZOO.

Work package 11: Consortium Management.

The project is coordinated by Wageningen University (The Netherlands) and EAZA. Wageningen University is responsible for monitoring project progress, editing project reports and general project administration. EAZA is monitoring and controlling to what extent the project progress agrees to the issues of concern of the beneficiary industrial branch: zoos and public aquaria.

CONCLUSIONS

CORALZOO is proceeding well. The coupling of the research infrastructure of the scientific partners to the facilities and technological knowledge present in public aquaria proved to be an efficient strategy to generate new knowledge. It enabled the execution of novel types of coral studies, such as long term growth experiments under controlled conditions and the demonstration of causal relationships between pathogens and coral diseases. The CORALZOO project was recently evaluated by the European Commission. The progress after the first two project years was marked as “excellent”.

In conclusion, CORALZOO provides a clear example of

- the potency of zoos and public aquaria as partners in science
- the added value of collaboration between scientists and aquarists
- the stimulating role that funding agencies such as the European Commission can play to develop aquarium science and technology

As such, CORALZOO can serve as a role model

for future collaborations between scientists and aquarists.

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INTERNET RESOURCES

www1. www.coralzoo.org



Figure 1: The CORALZOO team during the kick-off meeting of the project in June 2005.

Table 1: Participants and associates to the CORALZOO project.

Industrial grouping:	EAZA
Research institutes:	Wageningen University, The Netherlands (coordinator) Israel Oceanography and Limnology Research Institute Technical University of Dresden, Germany Italian consortium for Marine Sciences (represented by Polytechnical University de Marche, Ancona)
Zoos and aquaria:	Burgers' Zoo, Arnhem, The Netherlands Rotterdam Zoo, Rotterdam, The Netherlands Running Deep, Hull, UK London Zoo, London, UK Acquario di Genova, Genova, Italy Oceanario de Lisboa, Lisboa, Portugal Nausicaa, Boulogne-sur-Mer, France Oceanopolis, Brest, France Schoenbrunner Tiergarten, Vienna, Austria Tierpark Hagenbeck, Hamburg, Germany
Ornamental trade:	Red Sea Corals Ltd., Israel

Table 2: CORALZOO work packages

Work package 1	Bio-assay development
Work package 2	Fragmentation
Work package 3	Sexual reproduction
Work package 4	Abiotic factors
Work package 5	Nutrition
Work package 6	Health control
Work package 7	Transport and acclimation
Work package 8	Morphogenetic modeling
Work package 9	Protocol composition and dissemination
Work package 10	Training
Work package 11	Consortium management